12-2016

# Maine DOT Roads Report, 2016

Maine Department of Transportation


MaineDOT

# Roads Report

December 2016

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# Executive Summary

Managing transportation infrastructure and keeping up with its needs is a challenge. The satisfaction of building new roads (like the interstate in the 1950s and 60s), and the residential and commerce patterns that quickly grow up around new roads, all lead to high expectations about mobility and comfort. Concerns about preserving roads and extending their life can easily get pushed to the background. In many circles today, however, people are realizing the risks of not taking decisive action to preserve Maine's highway network.

Maine Title 23 (23 M.R.S. § 73, sub-§7), enacted in 2012, is a mechanism for monitoring the condition of Maine's highways and bridges, and for setting a timetable for measurable improvement to the network. The highway corridor priority (HCP) and customer service level (CSL) concepts introduced then already have been effective in organizing data and communicating the condition of the network. Specifically, by 2015, the HCP/CSL framework quantified and highlighted a growing sense that the roads in the middle, between the highest priority arterials and the lowest priority collectors, were in trouble. CSL data from 2012 to 2015 showed what at first seemed counterintuitive:

- The HCP 1 and 2 roads are holding fairly steady for condition CSL (though clearly not making progress toward the Title 23 goal of "no inadequate ratings by 2022").
- The HCP 3 roads are losing ground, and even less on track toward meeting their goal of "no inadequate ratings by 2027."
- Yet the HCP 4 roads clearly are improving and are on track for meeting their goal.

The graphs reinforce the lesson that funding a sufficient amount of cyclical maintenance paving (as has been done for HCP 4 roads) leads to improvement.

The message of the HCP/CSL graphs is reinforced by anecdotal observations. The available money is not covering even the basic preservation needs on the high priority roads. Field reviews are identifying sections of road that can no longer be preserved; they now require expensive rehabilitation before they can get back on a more cost-effective preservation cycle. These observations, along with the positive results achieved by the two Keeping Our Bridges Safe reports (2007 and 2014), triggered the formation of the Roads Report team at the start of 2016.

### *Key Findings of the Roads Report Team*

- **Maine is not on track to meet the Title 23 goals for HCP 1, 2 and 3 roads;**
- **Even more concerning, preservation of the highest priority roads is not fully funded;**
- **Expectations have increased dramatically in recent decades;**
- **Aging drainage structures pose a significant and growing risk.**

The Roads Report team focused on preserving the existing system, which carries the majority of Maine's traffic volume, and in which the state has made significant investments. All of these roads require ongoing preservation treatments, in order to avoid (or at least defer as long as possible) having to rehabilitate or

to rebuild them. The team looked at preservation needs from several angles and repeatedly found that historic preservation funding falls well short of covering all the miles. This is consistent with what we have experienced in developing recent capital work plans: HCP 3 preservation candidates do not compete well because it is clear that the funding will just barely cover the HCP 1 and 2 needs. To better address our highway network needs, the Roads Report team recommends the following:

## *Process Recommendations*

1. **Prioritize distribution of highway funding to meet preservation needs before rehabilitation or reconstruction of roadways.**
2. **Adopt revised Highway Corridor Priority classifications to better address our highway asset management needs.**
3. **Establish a Cyclical Pavement Resurfacing (CPR) Program to perform cycle paving on HCP 3B and 4A (Revised HCP 3) roadways.**
4. **Develop highway asset-based corridor management plans for HCP 1 and HCP 2 roadways.**

Neglecting preservation needs quickly leads to increased costs. After a certain point, neglected roads will require rehabilitation. Allowing roads to deteriorate to a point where rehabilitation is necessary is the least cost-effective way to manage a road. Again, looking from many angles, the team found that the most cost-effective strategy for preserving roads is to apply less expensive preservation treatments while the road still is in good condition.

Since preservation of our system is paramount, the Roads Report team looked hard at different strategies for accomplishing this. Using current treatment options, $122M per year is required to fully meet preservation needs. Working extensively with the HCP framework, the team found that realigning HCP would help with developing a more cost-effective approach. Therefore, the team recommends the following:

| Current Priority | Proposed Priority | Miles |
|---|---|---|
| HCP 1 | HCP 1 | 1485 |
| HCP 2 + HCP 3A | HCP 2 | 1872 |
| HCP 3B + HCP 4A | HCP 3 | 1852 |
| HCP 4B + HCP 5 | HCP 4 | 3450 |

The biggest change in this approach is the introduction of a new treatment for the roads in the middle. Cyclical Pavement Resurfacing (CPR) is an engineered mix that would be used on the lower priority roads. It would protect the considerable investment we have made in the road and keep future options open. Unlike full pavement preservation (right treatment at the right time) CPR would, for the most part, be on a nine-year cycle. This and other aspects of CPR keep its cost lower. By implementing CPR for the revised HCP 3 classification, preservation needs for the whole network would drop from $122M to $107M per year. Based on all that we considered, the Roads Report team recommends the following funding levels, listed in priority order.

## *Annual Funding Level Recommendations*

1. **Fully fund the preservation needs of our highway network ($107M)**
2. **Continue historic funding of Light Capital Paving (LCP) ($33M)**
3. **Continue historic funding of Safety and Spot Improvement and Mobility Projects ($20M)**
4. **Fully fund the drainage structure maintenance needs of aging infrastructure ($22M)**
5. **Continue historic funding of Plant Mixed Recycled Asphalt Pavement (PMRAP) ($8M)**
6. **Strategic investment in Highway Reconstruction/Rehabilitation ($TBD)**

***The Roads Report team recommends fully funding the first five priorities ($191 million per year) in this section before allocating funds to highway reconstruction/rehabilitation.***

The risks of not fully addressing preservation needs are clear. In addition, aging drainage structures present a risk of road closure or even a crash/loss of life. In any case, it is better to address drainage structures proactively than to have to respond on an emergency basis. If $191M is not available, the order of the list should be followed: i.e., fully fund #1 before applying any funds to #2, etc. If more than $191M per year is available, reconstruction/rehabilitation needs could be addressed, with the understanding that those miles will then need to be preserved.

# Understanding Our Roads

In December of 2015, the Maine Department of Transportation's Commissioner and Chief Engineer directed the development of the department's Highway Management Plan to review current and identify new management strategies for Maine's highway network.

A Roads Report team consisting of professional highway engineers from the Highway Management Group, Bureau of Project Development, and Bureau of Maintenance and Operations was formed to discuss the state of our highway system and current policies, assess the condition and performance of the system, and to make recommendations as to how we can maximize the return on investment in our highway assets. This document summarizes the work of that group to date and their recommended strategies for improving those assets.

The Maine Department of Transportation is responsible for about 8800 centerline miles of roadway within the state (excluding the mileage of the assets managed by the Maine Turnpike Authority). The management of this network requires asset information that is accurate and highly integrated with the rest of the department's data. Highway asset condition and performance data should drive maintenance work and capital investment decisions to maximize system performance and sustainability for the traveling public.

The needs of the transportation system in Maine, as in all other states, continue to outpace available federal and state resources. Our state's large land area, relatively low population, and high number of state-jurisdiction highway miles all contribute to Maine's challenge. **According to 2014 statistics, Maine ranks 7th in the nation in percentage of public miles that are state responsibility. Funding per centerline mile in other northern New England states is more than twice Maine's funding.** *(FHWA – Public Roads – Length by ownership – HM-10 – 2014; fhwa.dot.gov/policyinformation/statistics/2014/.)*

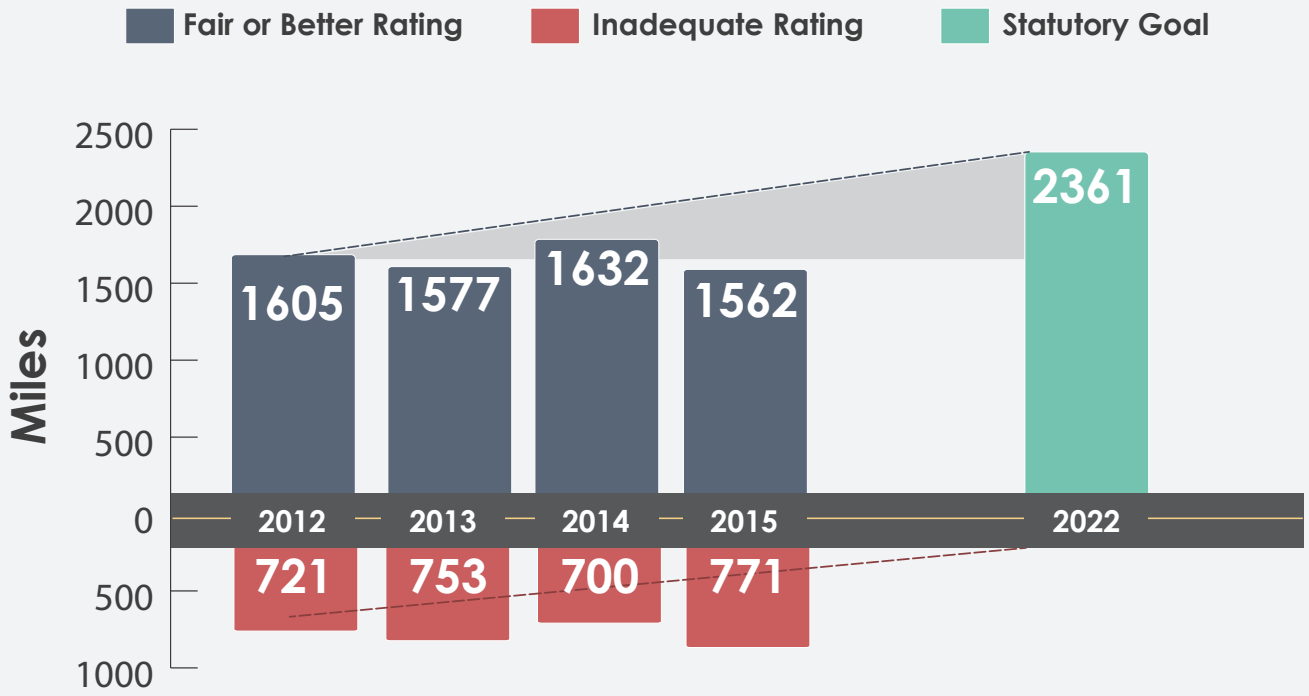
The challenge can be measured against capital goals established by the Maine Legislature in 2012 (23 M.R.S. § 73, sub-§7) to promote maintaining the state's highway system at an adequate level. These goals were established in the context of the department's Highway Corridor Priority (HCP) and Customer Service Level (CSL) methodologies.

### *The 2012 highway related goals specified in Section 7 include:*

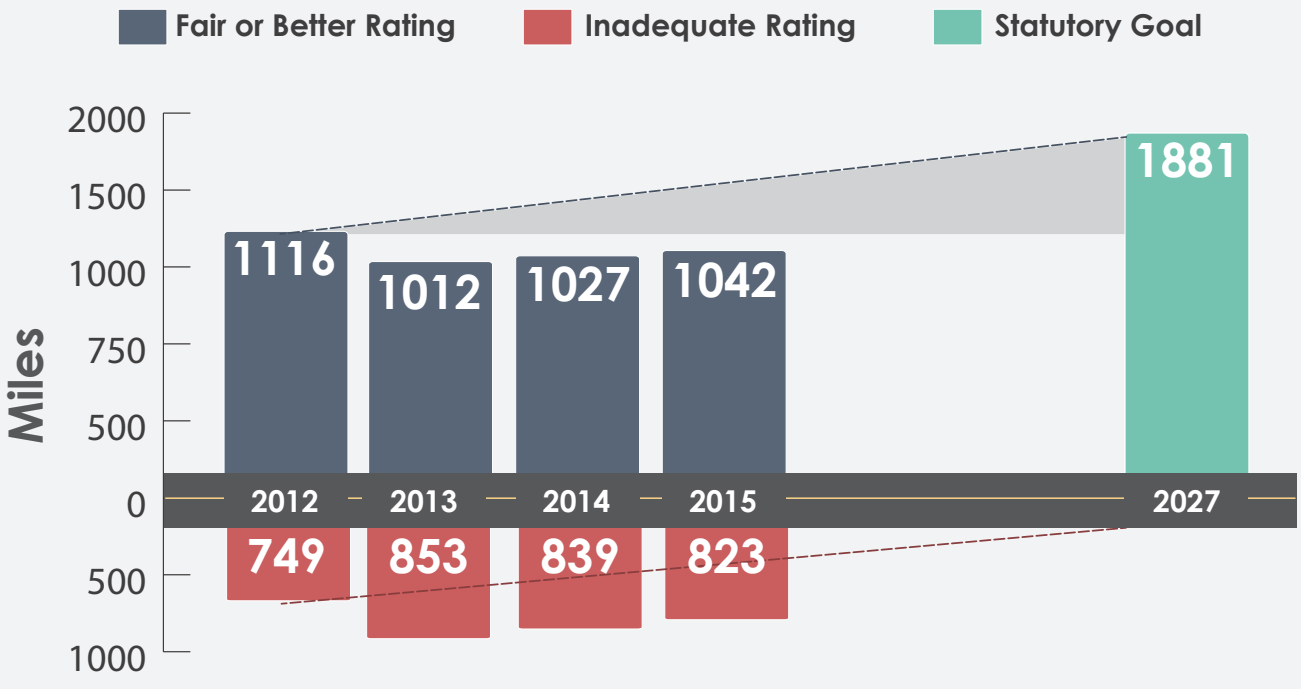
- **By 2022, improve all Priority 1 and Priority 2 highways so that their safety, condition and service CSL (customer service level) is fair or better;**
- **By 2027, improve all Priority 3 highways so that their safety, condition and service CSL (customer service level) is fair or better;**
- **By 2017, implement a pavement program for all Priority 4 corridors that maintains their ride-quality customer service level at fair or better;**
- **Continue the Light Capital Paving program on a seven-year cycle for Priority 5 highways.**

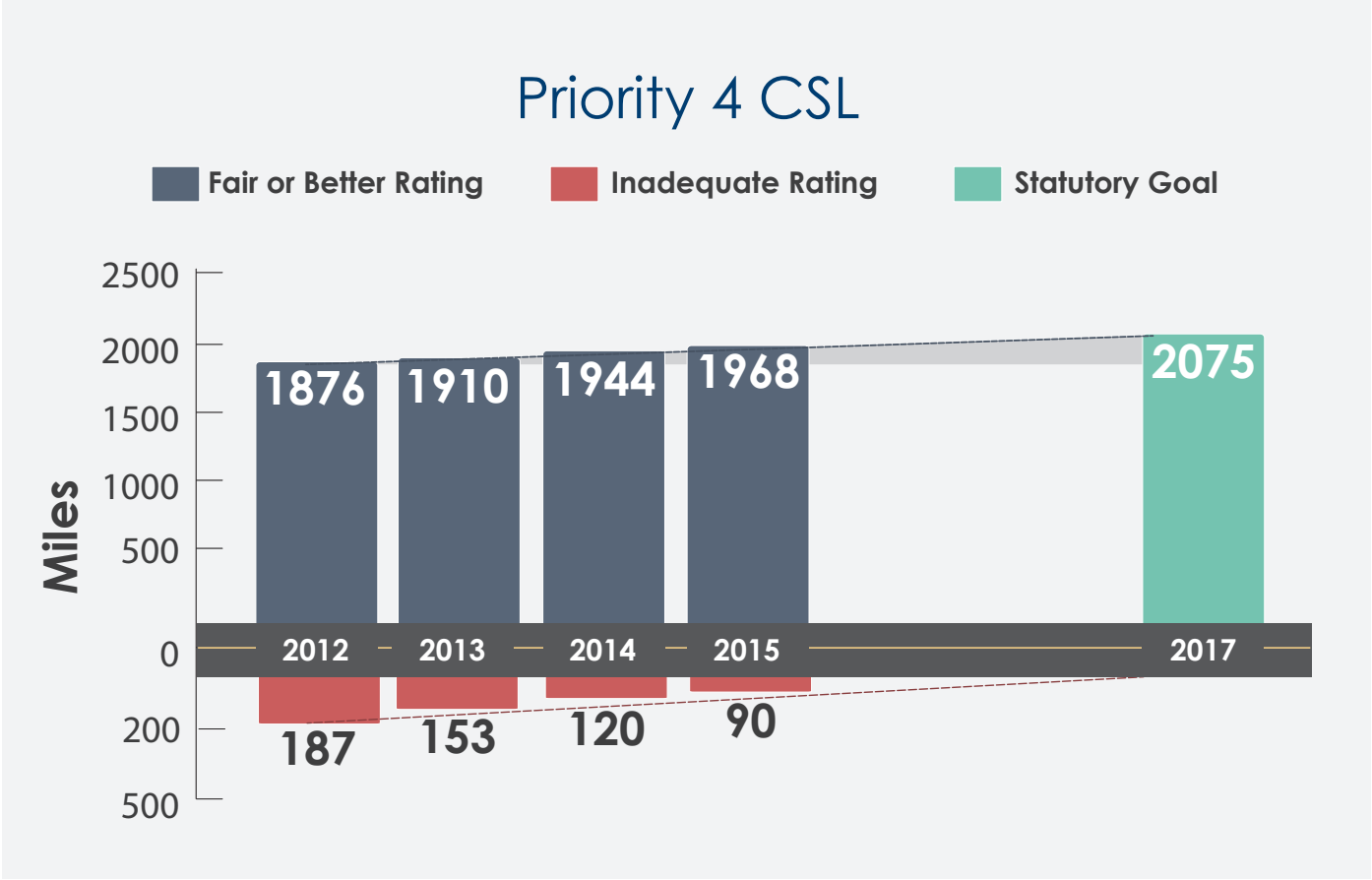
These goals were developed to address just the basic needs of the existing highway system. Unfortunately, **the gap between these targets and current highway customer service levels is growing. This is due to fiscal limitations and the reduced buying power the department has** as a result of steady increases in commodity prices in the past. It is illustrated by the following charts which show progress towards the statutory goals for CSL.

## Priority 1 & 2 CSL




## Priority 3 CSL



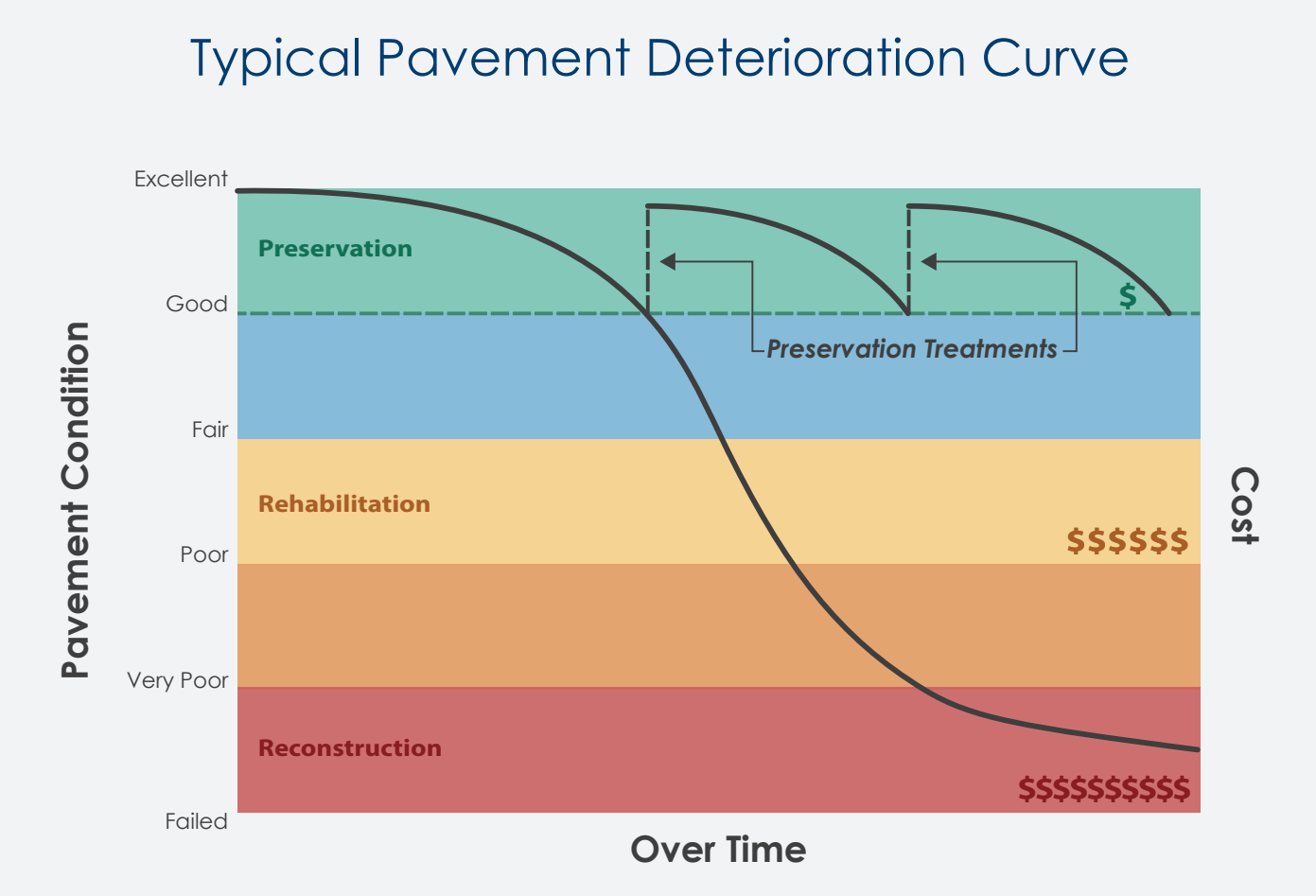



*The message of these graphs is that Maine is:*

- Not quite holding steady on the condition of HCP 1 and 2 roads, let alone making progress toward the Title 23 goals;
- Losing ground on the condition of HCP 3 roads; and
- On track for meeting Title 23 goals for HCP 4 roadways.

# Highway Pavements

**Our highway pavements begin to deteriorate the moment they are constructed.** The rate at which that deterioration occurs depends on the age of the pavement, traffic (particularly heavy trucks), drainage, and climate but follows the general deterioration curve illustrated below:




The curve shows that a roadway pavement deteriorates slowly at the beginning of its projected life span (the portion of the graph where the curve is nearly horizontal). This level of deterioration per year increases drastically (the portion where the curve becomes nearly vertical) as the pavement reaches near middle age and the effects of traffic and the environment take their toll on the material. When the pavement is near the end of its projected life span, the pavement worsens at a slower rate once again. The point where the pavement is in fair condition, before the curve drops off sharply, is considered the critical zone in the pavement's life. Before this point, it is relatively inexpensive to keep a roadway in good condition, while it becomes much more expensive to keep the roadway in good service condition beyond that point.

## *Pavement Preservation Treatments*

**Preservation** is work that is planned and performed to improve or sustain the condition of highway pavement that is in a state of good repair. Preservation treatments generally do not add capacity or structural value, but do restore the overall condition of the highway pavement. Source: FHWA Guidance on Highway Preservation and Maintenance Activities (*fhwa.dot.gov/preservation/memos/160225.cfm*)
In practice, this involves the timely application of cost-effective treatments to pavements that are still in

good condition in order to address pavement defects before more serious damage occurs. In other words, effective pavement preservation endeavors to "apply the right treatment on the right road at the right time." This extends the service life of our pavements and avoids, or at least defers as long as possible, the higher costs of pavement rehabilitation or reconstruction. To be effective, preservation treatments must be applied to roads in good condition without serious deficiencies in structure, geometry, and drainage. In terms of roadways under MaineDOT purview, preservation treatments are only applied to built roadways (those that have been constructed to modern design, material, and safety standards).

MaineDOT further refines preservation treatments into one of two types: **light treatments or heavy treatments.**

- **Light treatments** provide a new wearing surface for traffic and protect the underlying pavement on the roadway. Little or no correction of geometric or structural deficiencies is incorporated into the treatment. But minor surface distresses can be remedied with the treatments. These treatments include crack sealing, fog sealing, ultrathin bonded overlays, and thin hot mix asphalt (HMA) overlays (1" thick or less).
- **Heavy treatments** are applied to roadways in fair to good condition that have deteriorated too far for light treatments to be effective. However, they are still able to be preserved with a more substantial treatment. Ideally, the treatments would be applied to roadways that are structurally sound with surface deficiencies only. These treatments include mill and fill and 1-¼" HMA Overlays. But they also include some treatments that others might consider "light rehabilitation" such as hot-in-place-recycling (HIPR), and cold-in-place-recycling (CIPR), as well as light structural overlays and mill and fill treatments of 2 to 3 inch thickness. These treatments can correct moderate surface defects such as rutting and functional cracking. The strength of a pavement can be augmented slightly with the addition of thicker pavement layers. These treatments are generally limited to the existing pavement structure and, if enhancement of the base/subbase layers is required, the work moves to the pavement rehabilitation category.

## *Rehabilitation/Reconstruction*

The next category of roadway treatment used by MaineDOT is rehabilitation and reconstruction. These treatments are used to correct significant deficiencies in a roadway due to safety, geometry, structure or other concerns. These projects become necessary when the highway network's preservation needs are not met and cost 5 to 10 times more than preservation treatments to restore the highway's service life. These projects are also used to take existing unbuilt roadways within MaineDOT's network and bring them up to modern standards.

**Pavement rehabilitation** (or heavy rehabilitation) is used to restore pavements, in poor or worse condition, that have significant strength deficiencies, to a state where they can be preserved as part of our pavement preservation program. Rehabilitation treatments improve the strength of base and/or subbase pavement layers to support traffic loading, correct significant geometric deficiencies, and/or improve drainage. Rehabilitation treatments include: full depth reclamation, Plant Mix Recycled Asphalt Pavement (PMRAP), foamed asphalt, and Portland cement base stabilization.

**Pavement reconstruction** removes the entire existing pavement structure to subgrade and replaces it with new materials. Horizontal and vertical alignment changes, lane configurations, and significant drainage system replacement/installation can all be part of these projects.

With rehabilitation, and especially with reconstruction, it is generally true that the treatment can be deferred without significantly increasing its cost. In both cases, however, less expensive holding actions may be needed periodically to keep the roadway serviceable until rehabilitation or reconstruction can be funded. It also is important to plan for the future preservation needs of these roads, so that the substantial investment made in rehabilitating or reconstructing them is not lost.

## *Maintenance Paving*

The pavement preservation treatments are only applied to our built highway system in order to preserve our investment in those roadways. Maine has 4,345 miles of unbuilt highway. These have never been constructed to modern standards or are very low volume, low priority roadways that are nevertheless important to the public.

The **Light Capital Paving** (LCP) program is used by the department to address these roads by applying a thin maintenance surface treatment on a seven year cycle. This equates to approximately 600 miles of Light Capital Paving per year. The intent of this program is not to preserve or improve the roads, but rather to maintain the safety and serviceability of these roadways for the traveling public.

## *Cycle Paving*

What do you do when you can't afford to enact pavement preservation on all your built roads? Pavement management philosophy is to utilize the right treatment at the right time to reach the lowest average annual cost while maintaining the highest average service level. When this optimal solution is not economically viable, cyclical-based paving treatments should be considered. Cyclical treatment strategies treat a category of roads with the same treatment at a consistent interval. This typically results in a lower annual cost with the tradeoff of a lower average service level near the end of the cycle. This strategy has been successfully utilized on our unbuilt roads for the last 40 years in the maintenance cycle paving program – currently called the Light Capital Paving program.

The Cyclical Pavement Resurfacing (CPR) program would address the lowest priority of built roadways. With recent funding limitations, this category of roadways has received virtually no preservation treatments for the last four to six years. The CPR program would utilize engineered asphalt mix and would remove winter sand, and thus protect the structural investment made when the road was constructed. Included in the CPR treatments are necessary upgrades and repairs to guardrail, and corrections to the worst cross-slope deficient areas, thus improving the safety of the roadway.

It is anticipated that this treatment would save approximately $15 million a year over traditional pavement preservation strategies for this category of roadway. CPR is a tool in the MaineDOT tool kit that would be aimed primarily at roadways that in recent history have not received any treatments due to a lack of funding in the pavement preservation program. It would protect the investment made when these roadways were reconstructed and would maintain the roads in a condition such that pavement preservation could again be utilized in the future, if funds were available.

## *Resisting "Worst-First" Project Selection Pressure*

One of the hardest paradigm shifts a transportation organization has to face is embracing true pavement preservation principles and resisting the pressure to fix our worst roads first. "Why is MaineDOT paving that good road when Route X is in horrible condition?" The hard truth is that prioritizing work by "worst-first" is the **least effective** means of maintaining a highway network and expending limited highway funds. The table below shows average cost data for each category of treatment that can be applied to built roadways under MaineDOT control.

### Comparison of Treatment Costs to Life Expectancy

| Treatment | Expected Life | Avg. Cost per Mile | Cost per Lane Mile Year Extension |
|---|---|---|---|
| Reconstruction | 20 | $3,800,000 | $95,000 |
| Rehabilitation | 15 | $2,000,000 | $66,667 |
| 1-1/2" HMA Overlay | 11 | $430,000 | $19,545 |
| 1-1/4" HMA Overlay | 10 | $314,000 | $15,700 |
| Mill and Fill | 8 | $409,000 | $25,563 |
| 3/4" HMA Overlay | 9 | $233,000 | $12,944 |
| Ultra-Thin Bonded Wearing Surface | 8 | $175,000 | $10,938 |
| Cyclical Pavement Resurfacing(CPR)* | 9 | $135,000 | $7,500 |
| Fog Seal | 3 | $21,000 | $3,500 |
| Crack Sealing | 2 | $7,000 | $1,750 |

The preservation treatments can be done at a lower per-mile cost but do not last as long as the heavy treatments. However, the longer service lives that correspond with rehabilitation and reconstruction come with significantly higher costs. When compared against one another in terms of cost per mile per year of service life, the advantage of preservation strategies becomes clear. ***It is nearly five times more cost effective to the roadway network to use light preservation techniques as to reconstruct a roadway***. In more practical terms, the cost to reconstruct one mile of a poor condition roadway can be used instead to apply preservation techniques to keep 7-13 miles of roadway in fair to good condition for 6 to 9 years. We must continue to educate our customers and even our employees about pavement preservation principles and practices.

### *Recommendation 1*

**Prioritize distribution of highway funding to meet preservation needs before rehabilitation or reconstruction of roadways.**

## *Corridor Management*

### Highway Corridor Priorities

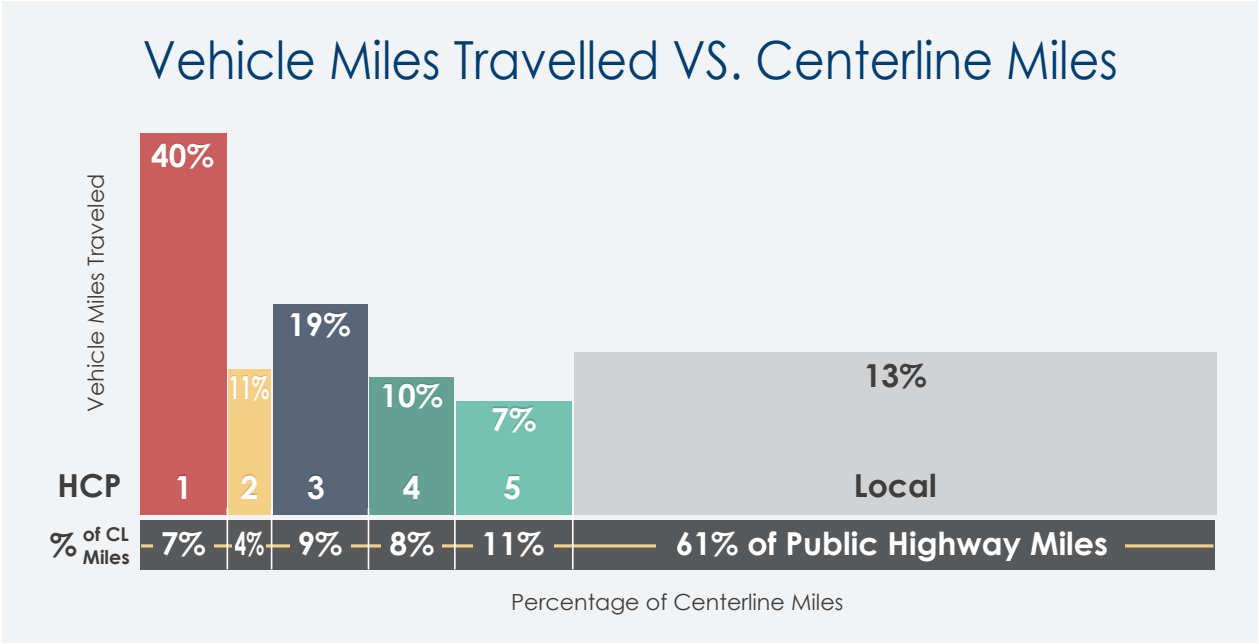
In order to guide investment decisions, the department uses a systematic approach to prioritize highway corridors and quantify customer-service levels. This Highway Corridor Priority/Customer Service Level

framework is based on two questions:

- What is the priority of the roadway?
- Given its priority, what level of service can highway users reasonably expect?

Larger and more heavily traveled highways are considered higher priority than smaller roads that carry less traffic. Interstate corridors have the highest priority, while collector roads and local streets are lower priorities on Maine's highway system. The current priority of specific highway corridors was determined in 2011 by a representative group at MaineDOT, which relied heavily on objective criteria such as the roadway's federal functional classification, percent truck traffic, the relative amount of traffic and the business activity the corridor supports. With this data, the HCP/CSL model classifies all 23,500 miles of public highways at one of six levels:

| Priority | Definition |
|---|---|
| HCP 1 | These roads include the interstate system and key principal arterials like Route 1 in Aroostook County, the Airline (Route 9), Route 2 west of Newport, and Route 302. The 1,400 miles of Priority 1 roads represent only 7 % of the miles, but carry fully 40 % of all vehicle miles traveled in Maine. |
| HCP 2 | These roads total about 940 miles. They are non-interstate, high value arterials that represent about 4 % of the total miles of road but carry 11 % of overall traffic. |
| HCP 3 | These roads generally are the remaining arterials and most significant major collector highways. These 2,050 miles represent only 9 % of miles, but carry 19 % of the traffic. |
| HCP 4 | These roads generally are the remainder of the major collector highways, often also part of Maine's unique state aid system, in which road responsibilities are shared between the state and municipalities. These 1,900 miles represent about 8 % of total miles, and carry 10 % of the traffic. |
| HCP 5 | These roads are 2,500 miles of minor collector highways, almost all on the state aid system. They represent 11 % of miles, but carry only 7 % of traffic. |
| HCP 6 | These roads are local roads and streets, and are the year-round responsibility of our municipal partners. Though they carry just 13 % of the statewide traffic, these 14,300 miles make up 61 % of the total miles. |



## *Built Versus Unbuilt Highways*

Within each highway corridor priority, some roads are considered built roads and some are considered unbuilt. A "built" road is a highway segment that is constructed to modern standards, whereas an "unbuilt" road has significant geometric and/or structural deficiencies and has more or less evolved over the years without being engineered to accommodate today's vehicle weights and traffic volumes. For HCP 3 and HCP 4 roadways, subcategories were developed to communicate these built and unbuilt sections with "A" roads being built, and "B" roads being unbuilt sections, resulting in designations such as HCP 3A and HCP 3B. The main purpose of designating segments an A or B road was to indicate whether the section was included in the pavement preservation program (A roads), or was historically included in the Light Capital Paving cycle (B roads).

Based on the recommendations for new highway corridor priority groupings proposed in the next section, the following table illustrates the type of work anticipated for built versus unbuilt roadway sections:

| Proposed HCP | Built | Unbuilt | Improvement |
|---|---|---|---|
| 1 | PPP | LCP | Rehab/Recon |
| 2 | PPP | LCP | Rehab/Recon |
| 3 | CPR | LCP | Rehab |
| 4 | LCP | LCP | MPI |

***Where PPP = Pavement Preservation Program, CPR = Cyclical Pavement Resurfacing, LCP = Light Capital Paving, and MPI = Municipal Partnership Initiative (cost-sharing with local municipalities).***

- Unbuilt HCP 1 and HCP 2 roadways will require a heavy rehabilitation or reconstruction project to move them from unbuilt to built status, at which point they will become part of the Pavement Preservation Program.
- Unbuilt HCP 3 roadways will require a heavy rehabilitation (typically PMRAP) to be considered built, at which point they will become part of the CPR cycle.
- Whether built or unbuilt, HCP 4 highways will remain in the LCP program and the only improvement they will receive would be through the MPI program, but they would remain in the LCP program afterward.

## *Is the Highway Corridor Priority System Working?*

The Roads Report team discussed the current HCP system and the policies for the various paving programs. They agreed that the existing priorities and sub-priorities were somewhat confusing for many department employees, and not really aligned with our current treatments. Of greater concern to the team, HCP 3 roadways continue to deteriorate. They don't compete well against HCP 1 and HCP 2 candidates in the prioritization process for pavement preservation funding. By current policy, they are generally not considered for Light Capital Paving (LCP) to maintain safety and serviceability.
The team identified HCP 3 roadways, that experience significant daily traffic volumes, that cannot be preserved under our current funding levels. A prime example would be Kennedy Memorial Drive in Waterville. It has over 19,000 AADT but as an HCP 3 does not compete well for pavement preservation dollars given the current prioritization process.

***Figure 1- Kennedy Memorial Drive - Waterville (Currently HCP 3)***

Adherence to HCP in the prioritization of project candidates would result in funding an HCP 2 highway with 4,500 AADT instead of preserving Kennedy Memorial Drive. Additionally, many of the HCP 3 roadways were reconstructed/rehabilitated as part of the Collector Highway Improvement Program (CHIP). This was a department focus in the last decade to reduce the number of insufficient/unbuilt collector highway miles. These CHIP projects required a significant investment, but now are falling into disrepair; current funding levels for preservation are only enough to address the 1 and 2 priority roads. Built roads are not eligible for LCP.

The team feels the best way to solve this issue is a realignment of HCP groups to better fit our treatment options and to allow high volume minor arterials and major collectors to compete. A key component of this strategy is the creation of a new paving treatment to address the proposed built HCP 3 mileage. The cyclical pavement resurfacing (CPR) treatment, consisting of an engineered ¾" HMA surface course with variable depth shim, would be applied to those built roads as a preservation treatment to extend the service life of these pavements.

## Proposed Changes to HCP Groupings

| Current Priority | Proposed Priority | Miles | Treatment |
|---|---|---|---|
| HCP 1 | HCP 1 | 1485 | PPP |
| HCP 2 + HCP 3A | HCP 2 | 1872 | PPP |
| HCP 3B + HCP 4A | HCP 3 | 1852 | CPR |
| HCP 4B + HCP 5 | HCP 4 | 3450 | LCP |
| HCP 6 | HCP 6 | 14,300 | Municipality |

*PPP = Pavement Preservation Program, CPR = Cyclical Pavement Resurfacing, LCP = Light Capital Paving.*

### *Recommendation 2*

**Adopt these revised Highway Corridor Priority classifications to better address our highway asset management needs and allow us to progress toward the legislative goals.**

### *Recommendation 3*

**Establish a Cyclical Pavement Resurfacing (CPR) Program to perform cycle paving on HCP 3B and 4A (Revised HCP 3) roadways. This would also provide a tool to apply a holding action to maintain safety and serviceability of HCP 1 and HCP 2 roadways that have deteriorated to a point where preservation is no longer an option and they are awaiting a programmed rehabilitation.**

## *Customer Service Levels*

MaineDOT has implemented a Customer Service Level (CSL) metric on an A through F scale as a means of measuring highway asset performance for the user. The CSL is determined using data on the safety, condition and service of the road. The result is a consistent tool to measure how a road compares to other roads of the same priority level.

| Component | Category | Definition |
|---|---|---|
| Crash History | Safety | Includes the two types of motor vehicle crashes most likely related to the highway-head-on and run-off-road crashes. The A-F scale compares these crash rates with the statewide average. |
| Paved Roadway Width | Safety | Compares total paved width (lane plus shoulder) with minimum acceptable widths by Highway Corridor Priority (not new design standards). If a highway segment fails this minimum, the Safety Customer Service Levels for that segment is decreased one letter grade. |
| Pavement Rutting | Safety | Looks at wheel path rutting since excessive rutting holds water and contributes to hydroplaning and icing in winter. The A-F scale set points vary by Highway Corridor Priority, and are based on hydroplane tests. |
| Bridge Reliability | Safety | This measure is pass/fail. If a highway segment contains a bridge with a Condition Rating of 3 or less (excluding non-overpass decks), the Safety Customer Service Level is decreased one letter grade. These bridges are safe, but may require increased inspection or remedial work that could affect traffic flow. |
| Pavement Condition | Condition | Uses the Pavement Condition Rating (PCR), a 0-5 scale that is composed of International Roughness Index, rutting, and two basic types of cracking. The A-F scale varies by Highway Corridor Priority. |
| Roadway Strength | Condition | Uses the results of the falling weight deflectometer, a device that estimates roadway strength. The A-F scale is uniform across Highway Corridor Priority, since even low-priority roads must support heavy loads in Maine's natural resource-based economy. |
| Bridge Condition | Condition | Converts the 0-9 national bridge inventory (NBI) condition ratings to pass or fail; it is uniform across Highway Corridor Priority. |
| Ride Quality | Condition | Uses the International Roughness Index (IRI), which is expressed in inches per mile of deviation. IRI is the nationally accepted standard for passenger comfort, and the A-F scale varies by Highway Corridor Priority. |
| Posted Road | Service | Each year, MaineDOT posts more than 2,000 miles of road during spring thaw to protect their longevity, but some posted roads directly affect Maine's economy. Road segments that are permanently posted get a D, while those with seasonal postings get a C. |
| Posted Bridge | Service | Uses load weight restrictions to arrive at an A-F score that varies by Highway Corridor Priority. |
| Congestion | Service | Uses the ratio of peak traffic flows to highway capacity to arrive at an A-F score for travel delay. Peak summer months are specifically considered to capture impacts to Maine's tourism industry. This scale is uniform across Highway Corridor Priority, since tourist travel is systemwide and sitting in traffic affects customer service similarly on all roads. |

The specific methodology for determining letter grades for each of the components l is described in detail in our *CSL Methodology* explanation found here: *mainedot.gov/about/assets/docs/CSLMethodology.pdf*

In summary, each of the components is assigned a letter grade of A through F where A=Excellent, B=Good, C=Fair, D=Poor, F=Unacceptable. The lowest grade for any one component within a category in the table will determine the CSL rating for that category. For each highway segment, we then calculate a Safety CSL, a Condition CSL, and a Service CSL grade.

While reviewing the CSL data to identify the specific cause(s) for poor or unacceptable ratings on our highways, the team identified a number of sections that received that grade solely due to low roadway strength scores within the Condition CSL.

### Miles with Condition CSL of D or F Due to Roadway Strength Component Only

| Priority | Built | Unbuilt | Total |
|---|---|---|---|
| HCP 1 | 4.33 | 4.06 | 8.39 |
| HCP 2 | 21.26 | 13.05 | 34.31 |
| HCP 3 | 65.5 | 101.81 | 167.31 |
| | | Total | 210.01 |

After spot-checking a number of areas meeting the above criteria, the team discovered that some roads appear to be performing quite well for their intended purpose. Although these sections may traverse weak underlying soils and/or wet areas, they do not show signs of significant damage from heavy trucks. The team consensus was that the network FWD data is not the reliable indicator of pavement strength and performance the department originally hoped it would be. It would be unwise to invest limited highway dollars trying to fix these weaker sections for pavements that are otherwise performing well, but this is work which would be required to achieve the Title 23 performance measure objectives. The department will be removing the Roadway Strength component from network level Condition CSL computations moving forward.

## *Corridor Management Plans*

In 2016, the department took a holistic look at our non-toll interstate system as a first step in developing formal asset management plans for our roadway network. This involved identifying all of the assets along the interstate system, assessing the condition of those assets, and developing a comprehensive and coordinated plan for preserving those assets.

A major goal of this effort is to coordinate planned work to minimize the time highway capacity is reduced due to lane closures and to limit the inconvenience and costs of our activities to the traveling public. Another goal would be to analyze the changes in heavy truck traffic and effects of 100,000-pound truck loads moving onto our interstate, which had previously been limited to 80,000-pound vehicles.

### *Recommendation 4*

**Develop highway asset-based corridor management plans for HCP 1 and HCP 2 roadways as a means to communicate and coordinate planned work on our highway assets as has been done for the interstate.**

# Assessment of Past Highway Investment

The following table illustrates MaineDOT's highway investment levels for the past five years:

## Total Project Value Delivered ($M)

| Program | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| Construction/Reconstruction | $55.9 | $40.3 | $46.5 | $35.2 | $31.0 |
| Rehabilitation | $5.0 | $23.2 | $49.6 | $28.1 | $21.1 |
| Pavement Preservation | $58.6 | $74.5 | $63.7 | $81.4 | $88.3 |
| Light Capital Paving (LCP) | $25.7 | $26.0 | $24.1 | $26.7 | $25.5 |
| Safety and Spot Improvements | $32.2 | $17.4 | $19.4 | $23.1 | $35.3 |
| Subtotal | $177.5 | $181.4 | $203.4 | $194.5 | $201.3 |

Highway safety and spot improvement investments are an instrument used to correct spot issues as they occur including high crash locations, environmental concerns, specific highway features, etc. In recent years, Maine has spent $20-$25 million for such efforts.

The following mileage table shows a breakdown of the remaining three highway program areas: pavement preservation, rehabilitation, and construction/reconstruction projects programmed for the same five- year period by highway corridor priority.

## Miles of Projects Programmed for Delivery 2011 - 2015 by Treatment & HCP

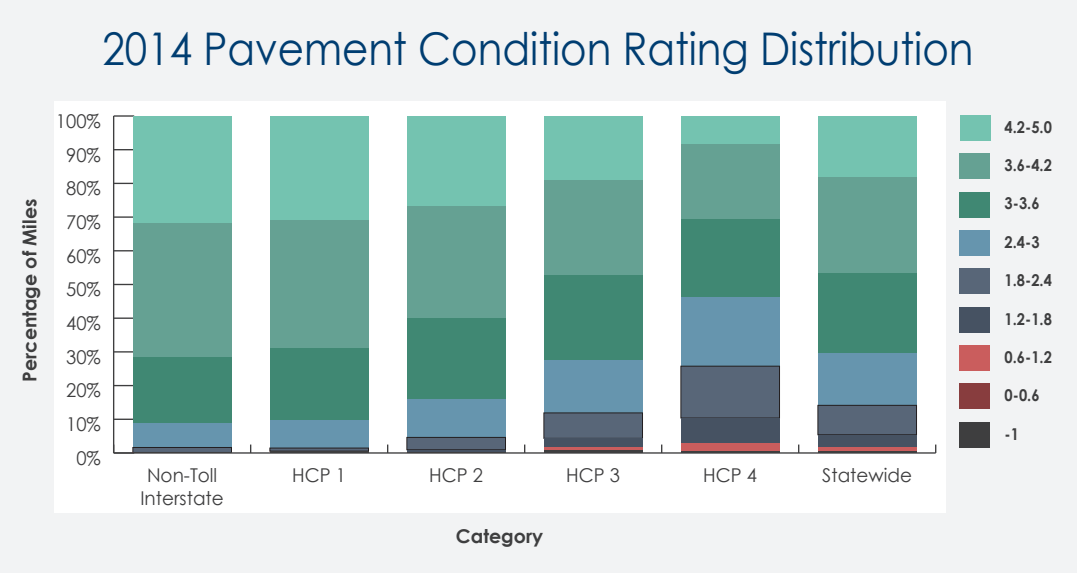
| Scope of Work | Highway Corridor Priority | | | | | Grand Total |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| **Highway Construction** | **17** | **12** | **23** | **8** | **4** | **64** |
| New Construction | 0 | 1 | | 1 | 2 | 3 |
| Reconstruction | 17 | 11 | 23 | 7 | 3 | 61 |
| **Highway Preservation Paving** | **436** | **273** | **350** | **77** | **23** | **1158** |
| 1 1/2 Overlay | 3 | 2 | 0 | 0 | 3 | 7 |
| 1 1/4" Overlay | 59 | 57 | 70 | 11 | 1 | 199 |
| 3/4" Overlay | 49 | 109 | 215 | 54 | 8 | 435 |
| 5/8" Overlay | 0 | | 22 | 0 | | 22 |
| Cold-In-Place Recycle | 3 | | | | | 3 |
| Fog Seal | 6 | 4 | 2 | 8 | | 20 |
| Mill and Fill | 265 | 101 | 34 | 4 | 9 | 412 |
| Structural Overlay | | | | 0 | 1 | 1 |
| Ultra Thin Bonded Wearing Surface | 51 | 0 | 6 | 0 | 0 | 57 |
| **Highway Rehabilitation** | **14** | **5** | **135** | **77** | **31** | **261** |
| Full Depth Reclaim | 0 | | 1 | 2 | 11 | 15 |
| Full Depth Reclaim with Cement | | | 10 | 3 | 0 | 13 |
| Highway Rehabilitation | 14 | 5 | 35 | 9 | 12 | 75 |
| PMRAP | | 0 | 23 | 11 | 3 | 37 |
| PMRAP Contracted | | | 28 | 7 | 2 | 37 |
| PMRAP DOT Pubmill | 0 | 0 | 37 | 44 | 2 | 83 |
| Grand Total | 468 | 289 | 508 | 162 | 58 | 1483 |

*Table Includes MPO and Interstate Mileage.*

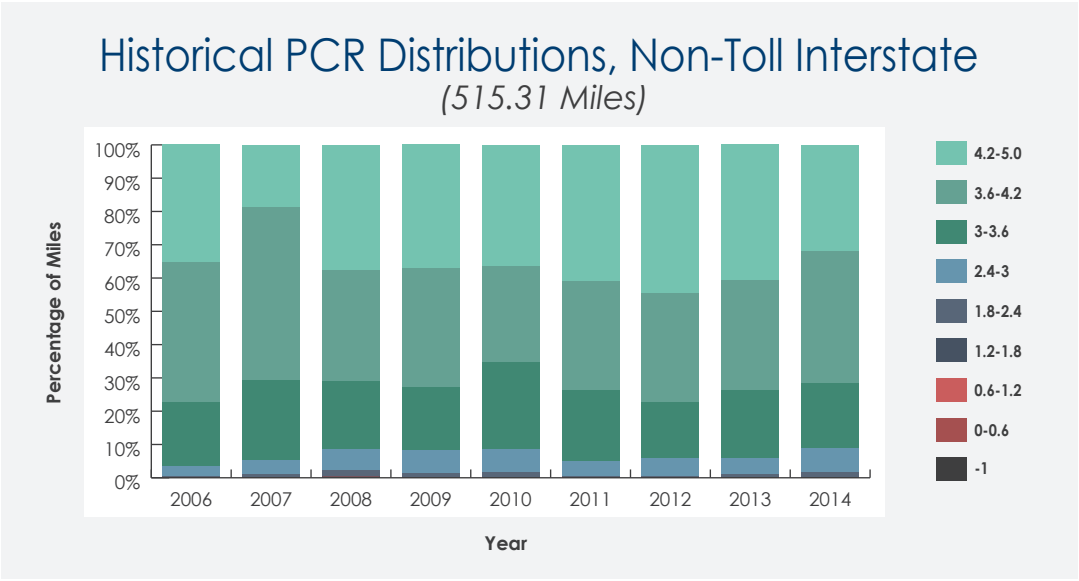
Since 2014, the department has sought out opportunities to use a less expensive Ultra-Thin Bonded Wearing Surface treatment for HCP 1 and HCP 2 roadways and the interstate where practicable. We have recently increased our use of this treatment both on the interstate and HCP 1 and HCP 2 roads for program years 2016 and 2017. Ultra-thin Bonded Wearing Surface shows promise as a cost-effective tool in the Pavement Preservation toolbox based on early observations of these sections from 2014 to 2015.

## *Current Condition of Maine's Highway Pavements*

The department monitors the condition of Maine's highway pavements by analyzing roadway data collected by the department's Automatic Road Analyzer (ARAN) data collection vehicle. Systems on this vehicle allow us to measure the wheel path rut depth, International Roughness Index (IRI), structural cracking, and functional cracking of our pavements. These four data elements are then equated to individual distress indexes, which are used to compute an overall Pavement Condition Rating (PCR) on a scale of 0 to 5 with 0 being impassable, and 5.0 being a brand new, smooth roadway with no rutting or cracking.

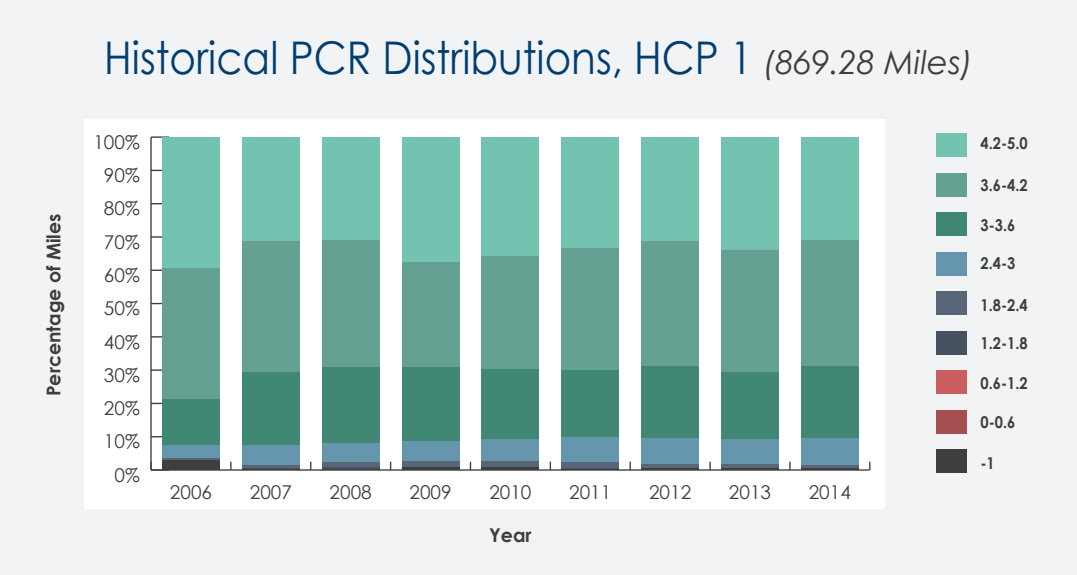



In 2014, more than 90% of our non-toll interstate, HCP 1, and HCP 2 roadways had a PCR of 3.0 or better. This is generally considered the PCR below which pavement preservation is no longer an option and a pavement requires a more costly structural overlay or rehabilitation. The charts that follow illustrate the changes in each of these categories over time:

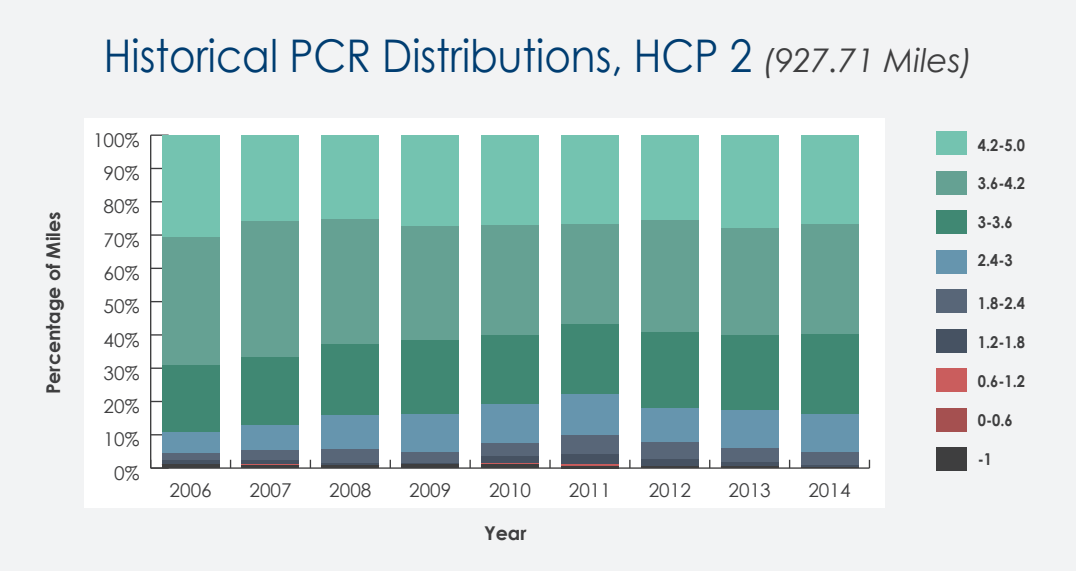



The interstate system is vital to the economy of Maine and experiences large volumes of traffic, particularly heavy truck traffic transporting goods into and out of the state. Given its importance and

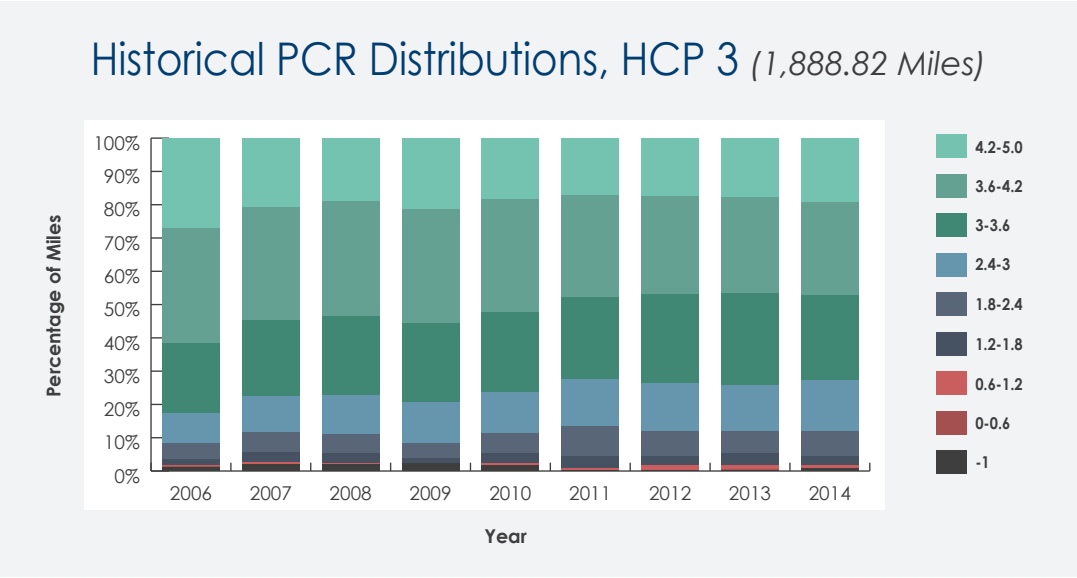
rate of deterioration, the department does set its condition standard higher than for other roadways in the state. An Interstate Operating Plan has been developed to manage this asset moving forward from 2016. The distribution of pavement condition rating appears to have held steady for the interstate system for the last eight years. However, it can be observed from the chart that the percentage of poorer quality pavement has increased since 2012 on the interstate. The possible reasons for this change will be further discussed in the Challenges section of this report.



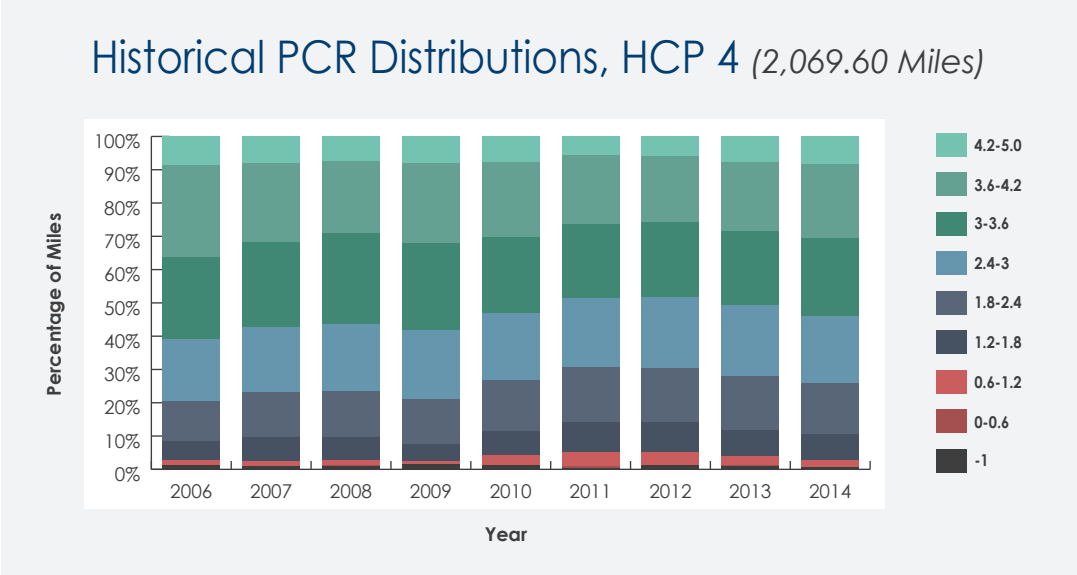

Investments made in non-interstate HCP 1 roadways have maintained a fairly consistent pavement condition distribution, though an increase in rehabilitation/reconstruction for about 10% of these miles would be needed in order to meet Title 23 goals.




From 2006-2011, HCP-2 was losing ground, but recent investments seem to have stabilized the percentage of preservable miles in this category. It can be noted that over 15% of these miles are already below the threshold for preservation strategies and will require some sort of rehabilitation/reconstruction.




HCP-3 roadways are currently at high risk for accelerated deterioration due to prioritization policies and recent investment levels. In the mid to late 2000's, significant mileage was improved in a relatively short period of time through the Collector Highway Improvement Program (CHIP). These pavements are of similar age, creating a "preservation need bubble" that is beginning to come due or, in some cases, is past due. The current PMRAP program has replaced the CHIP program but the effect is similar. There is continued improvement to some of our worst roadways in this category, adding them to the pavement preservation program. Unfortunately, these built HCP 3 highways do not compete well against higher priority roadways for pavement preservation funding during prioritization, and they are not generally eligible for LCP. Without increased preservation investment in these roads, they will soon see accelerated deterioration as they near the end of their service lives. Even with additional funding, there is a significant percentage of HCP 3s that have deteriorated past the condition where preservation strategies are effective.




These highways are in a similar position to HCP 3 highways. They, too, are improved through the PMRAP program, and a large portion of these highways receive cycle paving as part of the LCP Program. Much like the HCP-3 highways, the majority of HCP 4 highways have already deteriorated past the effective point of preservation strategies. This means more costly rehabilitation treatments are needed to address the roadway deficiencies.

## *Network Service Life Loss*

Every paving project applied to sections of Maine's highway network extends the service life of those roadway segments receiving the treatments. Simultaneously, each segment of our highway network ages or loses service life each year whether treated or not. For our network to remain in its current state, enough service life must be added into the system to at least equal the service life lost each year.

Service life can be measured in terms of "lane-mile-years" (LMY). For example, one mile of two-lane highway will lose two lane-mile-years of service life each year. The following table contains a breakdown of our lane miles totals by Highway Corridor Priority with the interstate considered separately:

### Lane Miles by Highway Corridor Priority

| HCP | Total LM | Built LM | Un-built LM |
|---|---|---|---|
| Interstate | 1028 | 1028 | 0 |
| 1 | 1888 | 1784 | 103 |
| 2 | 1989 | 1841 | 148 |
| 3 | 3799 | 2968 | 831 |
| 4 | 4147 | 1601 | 2546 |
| 5 | 4741 | 406 | 4334 |
| Totals | 17592 | 9630 | 7962 |

***Includes MPO mileage – Excludes MTA Toll Road Mileage***

For analysis purposes, we are primarily interested in determining if sufficient treatments are programmed to meet the service life loss of the built roads in pavement preservation. This would exclude all HCP-5 roadways and any higher priority built highway segments currently receiving light capital paving on a cycle. Based on this:

*Maine's non-toll built highway system will **LOSE** approximately 9,224 lane mile years of service life each year.*

Different treatment types extend service life by different amounts so the amount of service life extension we apply each year varies depending on the mix of treatments applied. Using data from the tables in the previous section, the service life extension programmed in the past five years can be calculated and evaluated to see whether the service life extension need was met.

## Service Life Analysis for Non-Toll Built highways

| | | Centerline Miles | | | | | Life Extension (LMY) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | Expected life | 2011 | 2012 | 2013 | 2014 | 2015 | 2011 | 2012 | 2013 | 2014 | 2015 |
| Reconstruction | 20 | 21 | 4 | 9 | 8 | 13 | 840 | 160 | 360 | 320 | 520 |
| Rehabilitation | 15 | 15 | 51 | 104 | 79 | 63 | 450 | 1530 | 3120 | 2370 | 1890 |
| 1-1/2" overlay | 12 | 3 | 2 | 0 | 0 | 0 | 72 | 48 | 0 | 0 | 0 |
| 1-1/4" overlay | 10 | 43 | 36 | 32 | 48 | 38 | 860 | 720 | 640 | 960 | 760 |
| 3/4" overlay | 8 | 59 | 102 | 84 | 89 | 93 | 944 | 1632 | 1344 | 1424 | 1488 |
| 5/8" overlay | 7 | 6 | 9 | 7 | 0 | 0 | 84 | 126 | 98 | 0 | 0 |
| Fog Seal | 3 | 0 | 0 | 0 | 14 | 6 | 0 | 0 | 0 | 84 | 36 |
| Mill and fill | 10 | 62 | 119 | 70 | 79 | 74 | 1240 | 2380 | 1400 | 1580 | 1480 |
| Ultra-Thin | 6 | 0 | 0 | 0 | 19 | 38 | 0 | 0 | 0 | 228 | 456 |

## Net Service Life Gain/Loss

| | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| Program Service Life Extension | 4490 | 6596 | 6962 | 6966 | 6630 |
| Annual Service Life Loss | 9224 | 9224 | 9224 | 9224 | 9224 |
| Net Service Life Gain/Loss | -4734 | -2628 | -2262 | -2258 | -2594 |
| Surplus/Shortfall Percent | -51.3% | -28.5% | -24.5% | -24.5% | -28.1% |

Anticipated service life extension for each treatment type shows that projects programmed for the last four years have **fallen nearly 25% short of the life extension needed** to match the service life loss of our non-toll built highway network.

# Future Highway Funding Needs

## *Preservation Needs Analysis*

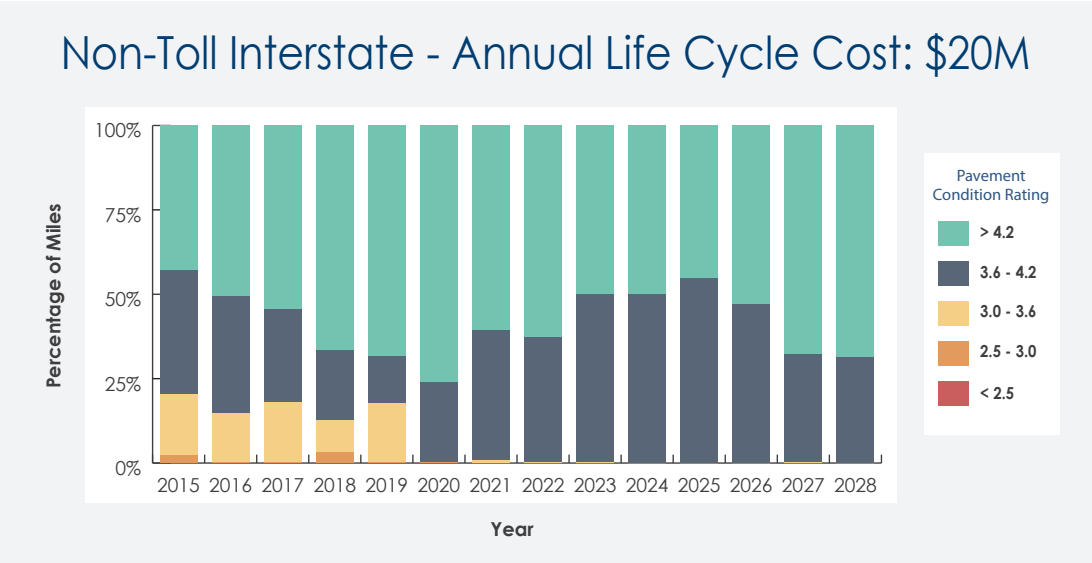
The department uses dTIMS CT asset management software to model each section in the 8,800 mile network. The model considers factors such as year of last work, traffic (AADT) and cost and effectiveness of the various treatments in the department's toolbox. It predicts deterioration on each section and evaluates many different ways of investing money over an analysis period (usually about 15 years). Once all the possibilities have been calculated out, it chooses the construction program that will deliver the highest benefit. (A construction program recommends specific treatments on specific sections of road for each year in the analysis period.) Benefit is the product of improvement in PCR multiplied by an AADT (Annual Average Daily Traffic) factor, i.e. how many drivers see that level of improvement.

Besides providing a starting point for selecting Work Plan candidates, dTIMS CT analysis can be used to visualize the long-term effects of different levels of funding. As part of its work, the Roads Report team ran analyses to determine the funding needed to preserve the parts of the network that are still preservable (i.e., unbuilt sections were excluded). In all cases a "do-nothing" budget scenario was run, to be a reference point.

### Non-Toll Interstate HCP 1

The current interstate system consists of 509 miles of two-lane highway maintained by the Maine Department of Transportation. Approximately 390 miles are on I-95, 4 miles on I-195, 102 miles on I-295, 10 miles on I-395, and 2 miles on I-495 (the Falmouth Spur). For these highest priority roadways in the state, all future funding needs scenarios meet the customer service level goals of Title 23.

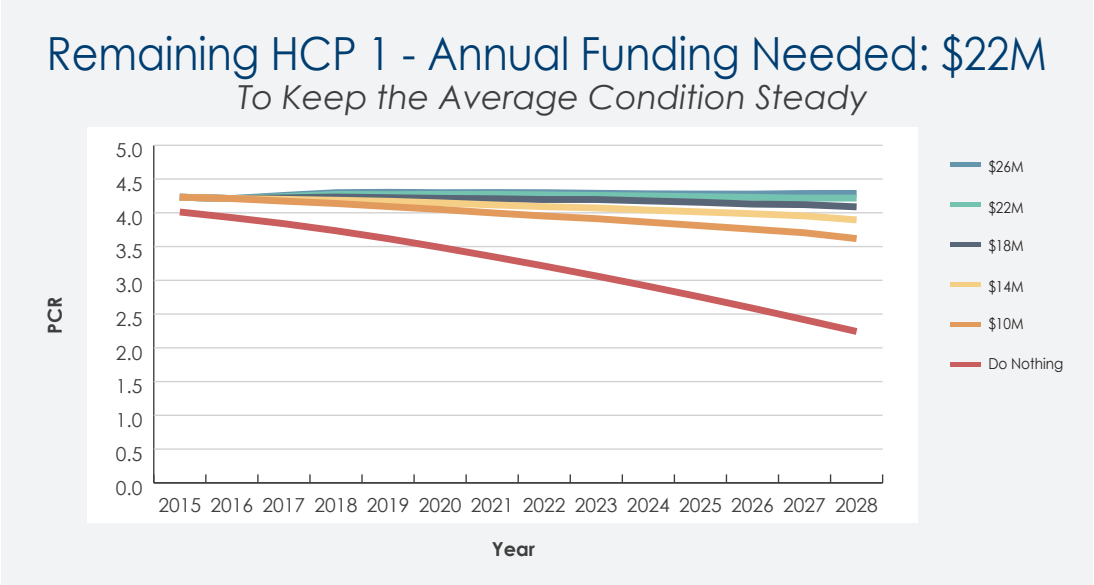
MaineDOT has conducted extensive research and analysis on the pavement deterioration on the interstate system. The department developed a preservation/rehabilitation strategy with a mix of treatments that focus on heavier preservation treatments at first. This will bring the system up to a condition to transition to primarily light treatments within six years. The cost of this strategy is $20M per year through 2020. It is then reduced to an annual expenditure of $16M per year beginning in 2021. The projected condition distribution as a result of these levels of investment is illustrated in the following graph:

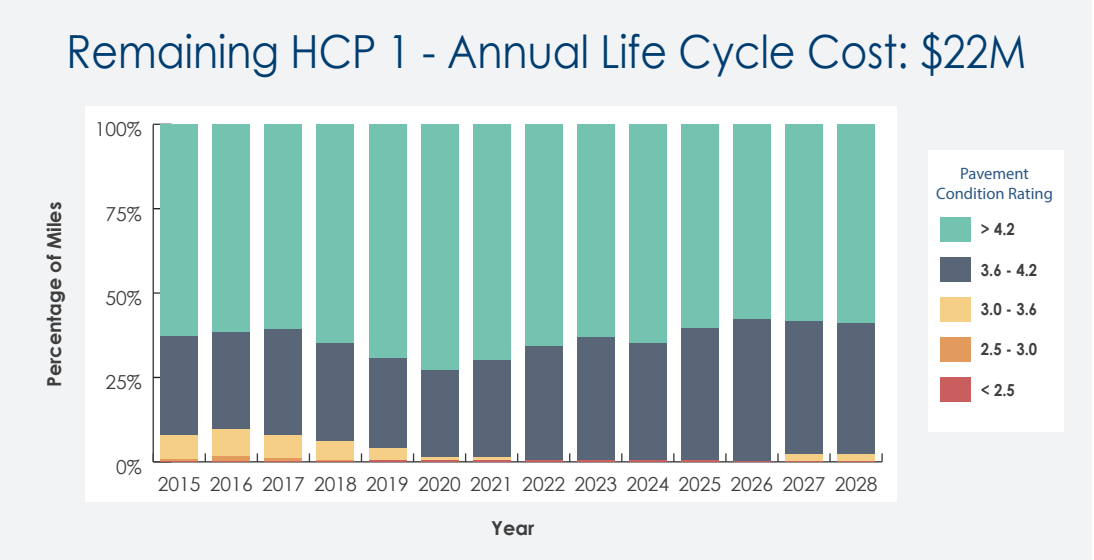


## Remaining HCP 1

For the remaining 817 miles of built HCP 1, the following graphs show that funding of $22M per year is needed to hold the average condition of that network steady. In this funding scenario, heavier preservation treatments (including rehabilitation) are used in the early years to address the C, D and F sections; then it is possible to keep all sections in the A/B range using just lighter (less expensive) preservation treatments like fog seal, ultra thin bonded wearing surface and ¾" overlay. This is analogous to periodically reshingling a roof (at a lower cost) and thus avoiding more expensive repairs to the roof deck, or damage to the interior of the building.

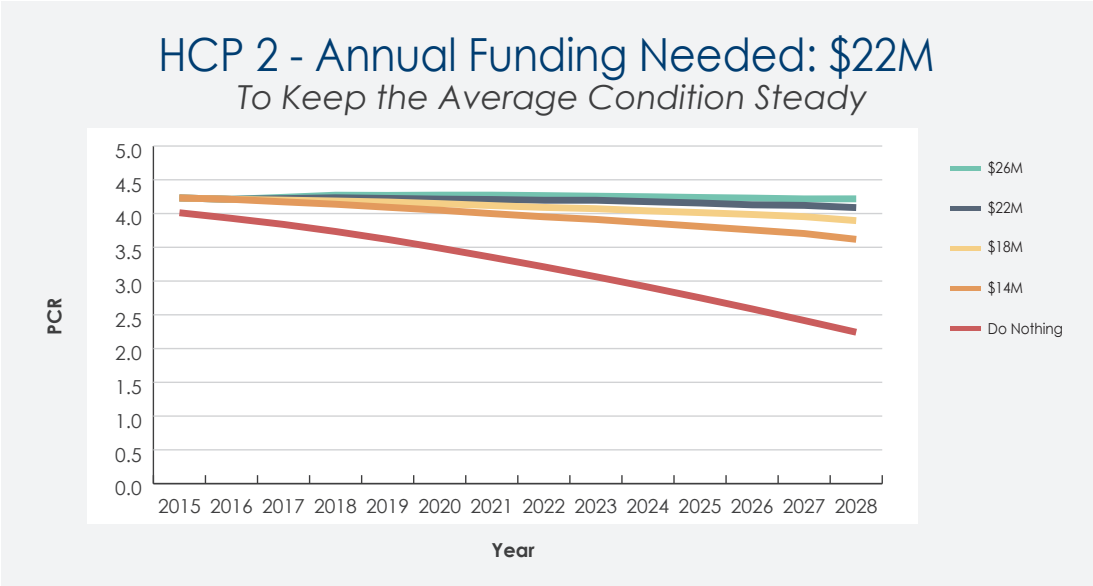
The historical data (2006 – 2014) for HCP 1 roads show that recent strategies have been holding a fairly constant average condition. The models also show a clear preference for light preservation strategies as they are shown to be the most cost-effective. Over the life of the analysis, the model directs a total of 86% of preservation funds to light treatments. This is a clear departure from treatment selections in recent years. Information presented earlier showed that only 24% of miles treated through preservation from 2011 to 2015 were given light treatments; most were mill and fills on HCP 1 highways.

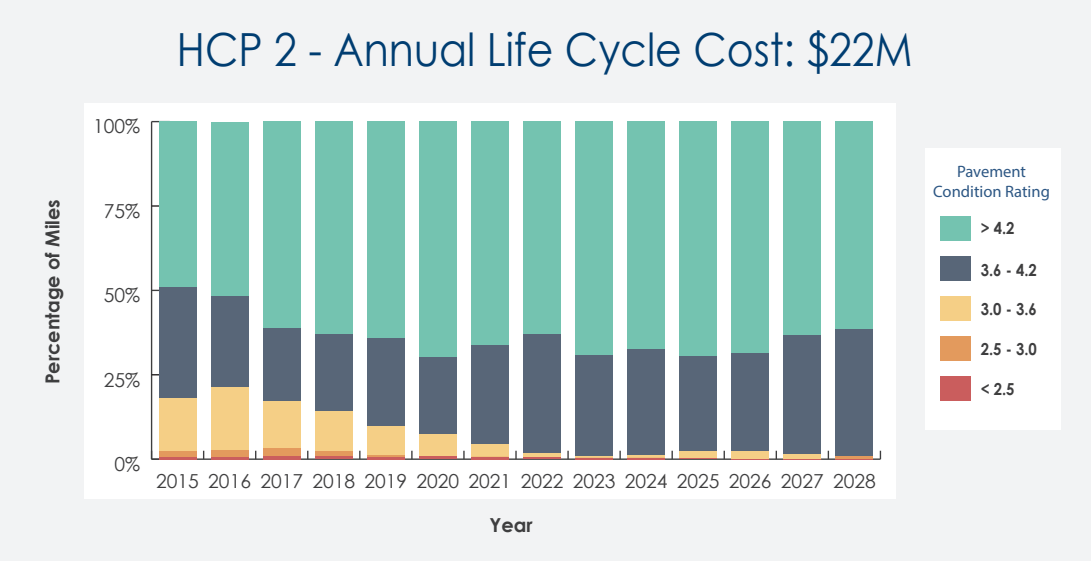


## HCP 2

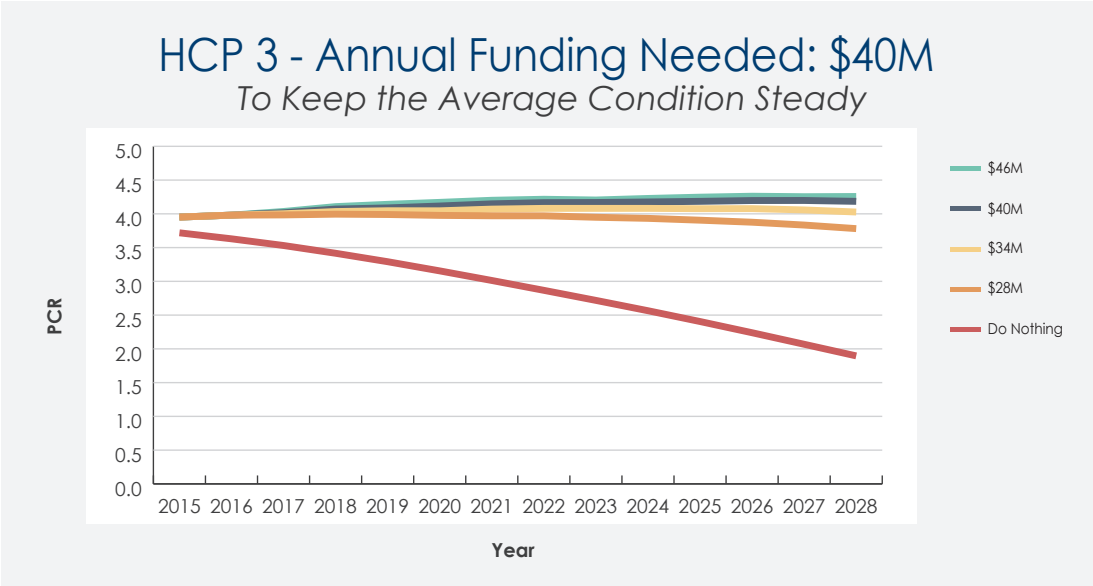
For the 854 miles of built HCP 2 roads, funding of $22M per year is needed to hold the average condition of that network steady. As with the HCP 1 sections, in this funding scenario heavier preservation treatments are used in the early years to address the C, D and F sections; then it is possible to keep all sections in the A/B range using just lighter (less expensive) preservation treatments. The historical data show a slight decline in average condition between 2006 and 2012, from 3.9 to 3.6. That trend began to turn around in 2012, and so far has recovered to 3.8, likely because of a conscious shift to a policy of addressing preservation needs on the higher priority roads first, even at the expense of losses on lower priority roads.

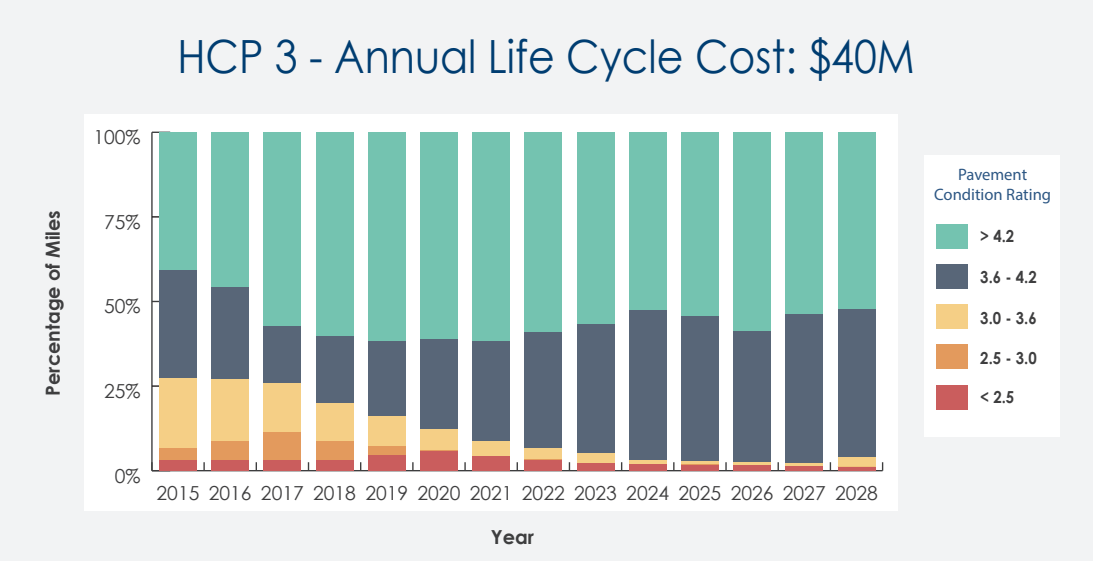


## HCP 3

The mileage for built HCP 3 roads (1,497) is nearly twice that for HCP 2. The funding needed to hold the average condition of the HCP 3 network steady is $40M per year. The historical data show a significant decline in average condition between 2006 – 2012, from 3.8 to 3.5; by 2014 it has leveled off at about 3.5, but is not recovering. This is consistent with the department's experience in programming pavement preservation for recent Capital Work Plans: preservation needs for HCP 1 and 2 use up the available funding. Without a change in resource allocation, more of the HCP 3 mileage will deteriorate to the point where they need more expensive treatments.




The condition distribution graphs for HCP 1, 2 and 3 roads are similar in that, by the time the network achieves a steady-state, well over half of the miles have a PCR above 4.2. For HCP 1 roads, this corresponds to a pavement condition rating (PCR) CSL of A. The team found that using the lower PCR ranges for HCP 2 and 3 (e.g., for HCP 3, a PCR as low as 3.8 is still considered an A) resulted in graphs that showed nearly all the miles as A. Therefore, we chose to use the PCR ranges for HCP 1 for all the graphs (without any reference to those letter grades), so that it would be clearer to see the progressions through the analysis

period. This all illustrates a key lesson: the most cost-effective way to keep a network from deteriorating out of control is to "keep the good roads good." While customers may be willing to accept worse conditions on the lower priority roads, there is no escaping the fact that once a built road falls below PCR of about 3.0, more expensive treatments are needed. While these more expensive treatments last longer, the extended life does not pay for the much higher cost per mile.

## Summary of Annual Funding Needs

| Highway Corridor Priority | Historical Preservation Funding (2010-2014) | Annual Preservation Funding Need | Historical Rehab + Constr. Funding |
|---|---|---|---|
| Interstate | $16M per year | $16-20M per year | $ 3.5M per year |
| Non-interstate HCP 1 | $11.7M per year | $22M per year | $14.7M per year |
| HCP 2 | $13.7M per year | $22M per year | $10.7M per year |
| HCP 3 | $13.5M per year | $40M per year | $22M per year |
| HCP 4A | $ 2.5M per year | $18 M per year | $ 5M per year |
| Total | $57.4M per year | $122M per year | $55.9M per year |

Current total funding of $113M per year is not enough to cover the annual preservation funding need of $122M per year, even if no investment was made in reconstruction/rehabilitation. Applying all of the currently available funding ($113.3M) to preservation is one option.

This would be a significant shift in policy, but it is one way to keep more miles from falling out of the preservable category into the rehabilitation category. The miles of unbuilt roads would remain stagnant as there would be nearly no remaining funding for treatments to properly construct these roadways. These unbuilt roadways, in many cases, represent the CSL Ds and Fs in the MaineDOT system.

## *Drainage Structure Maintenance*

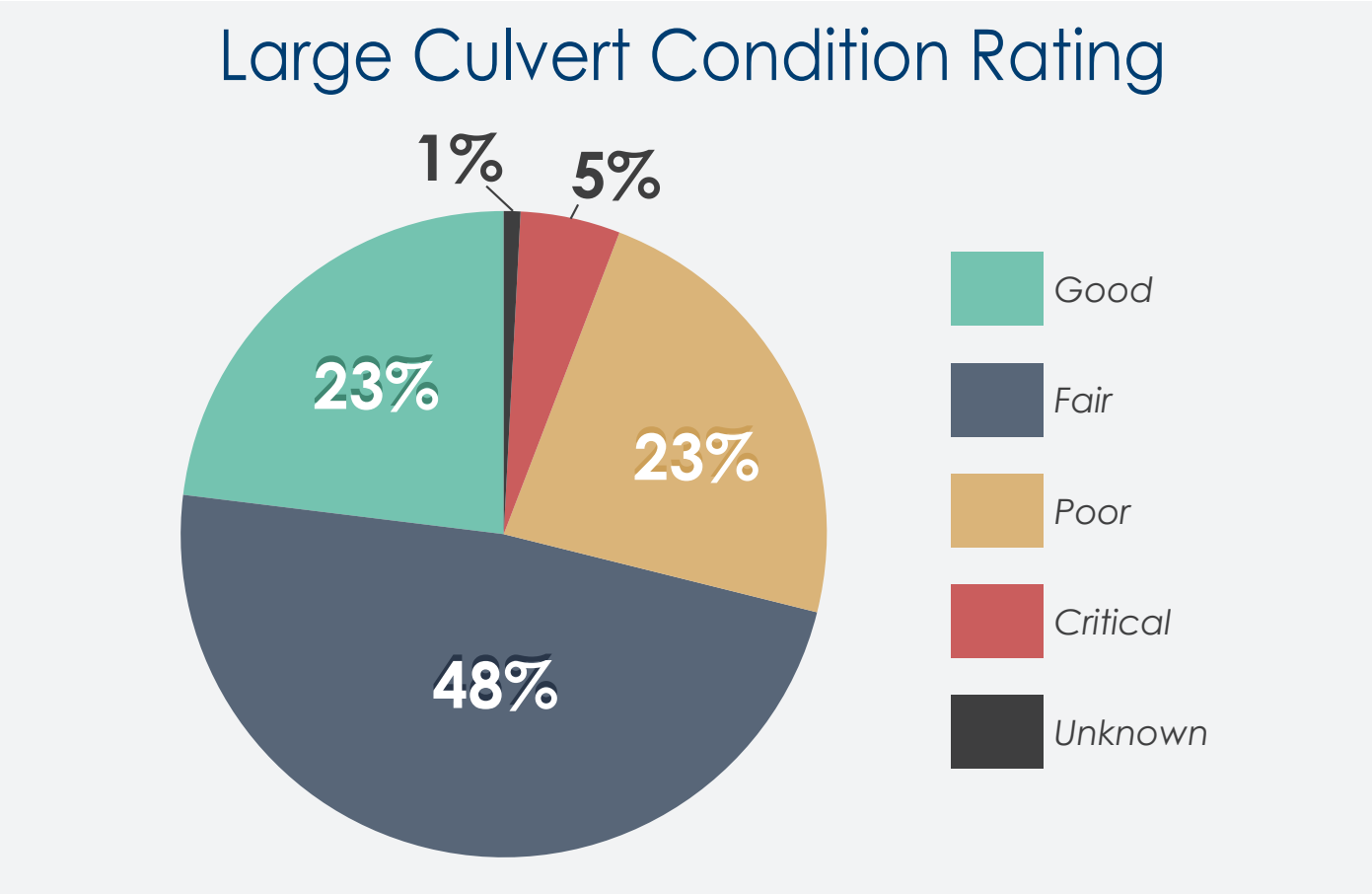
Culvert replacement is an aspect of infrastructure repair that, in many ways, transcends corridor priority. While, when speaking about pavement condition, there are expected and acceptable variances reflecting priority, failing culverts present a much more definable hazard regardless of location. Additionally, the concept of preservation does not typically apply to the maintenance of culverts. As there is no practical and accepted engineering treatment aimed at preserving and extending the life of a culvert, the practice is to install and replace them when they've nearly reached the end of their serviceable life. In many instances, this does involve replacing on a "worst-first" basis.

MaineDOT categorizes crossing drainage structures as bridges, large culverts, or cross culverts. Bridges are structures spanning 10 feet or greater, the maintenance of which is outlined in the Keeping Our Bridges Safe (KOBS) report. Large culverts are those less than 10 feet but greater than or equal to 5 feet, and cross culverts are those smaller than 5 feet. Presently, there are 1,730 large culverts throughout the state, and over 38,000 culverts (excluding driveway/entrance culverts). This number excludes any of these assets that fall within a state urban compact.

Changes in both storm patterns and environmental permitting requirements over the past decade have had an effect on cost, constructability, and the ability to efficiently maintain these assets. Larger runoff events have been occurring at a greater frequency, causing a change in design practice, generally increasing the size and hydraulic capacity of these structures. Further changes in design have resulted from agreement with the fishery agencies to provide improved fish passage.

Over the past five years, the average cost of replacing a large culvert has increased from approximately $170,000 to $260,000. At current average cost, the replacement value of this asset group is approximately $452M. In 2015, in an effort to remain atop the large culvert needs, the department reallocated funding for the 2017 Work Plan, increasing the statewide dedicated large culvert funding to $5M. Large culvert replacement has also occurred due to supplemental funding from the Bureau of Maintenance and Operations, and as part of larger capital reconstructions projects. On average, this combined effort has accounted for approximately 34 large culvert replacements per year.

The breakdown of the present condition of the 1,730 large culverts is illustrated in the following chart . When approximating service life remaining per condition rating, and deducting a year of service life for each year that passes in the cycle, it has been determined that 46 large culverts will need to be replaced annually to establish a maintainable cycle. At a current average cost of $260,000 per replacement, the annual cost of maintaining our present system of large culverts is approximately **$12M.**




On average, cross culverts presently cost $5,500 to replace. This means the total replacement value of our culvert inventory is approximately $210M. However, like large culverts, changes in design approach have led and will continue to lead to the upsizing of some of these structures, which in turn, will lead to a cost increase. Applying the same methodology as with large culverts, at current cost and estimated life span, it is projected that approximately **$5.5M** should be spent annually maintaining cross culverts to provide a stable cycle.

Unlike large culverts, cross culvert replacement has less of a tendency to be performed on a "worst first" basis. Rather, a corridor approach that aligns with pavement treatment is typically employed. Analysis of culvert condition is conducted prior to a pavement treatment and, given available resources, if the remaining life of the culvert is projected to be less than the life of the pavement treatment, the culvert is typically replaced.

Yet another aspect of drainage maintenance is closed drainage. In developed areas where roadside ditches cannot be established, closed drainage is installed to convey both surface and subsurface water. This asset is particularly challenging to maintain because visual inspection on a regular basis is impractical, as it must be accomplished by a remote camera. For this reason, condition rating and precise inventory for most of the closed drainage systems does not exist. Excluding assets inside state urban compacts, the closed drainage system comprises approximately 19,000 catch basins and an estimated 2.8 million linear feet of pipe, placing the replacement value of this asset group at approximately $180M. This equates to an annual expenditure of approximately **$4.5M** to maintain this system. This number is likely to increase drastically when accounting for potential capital expense to replace systems inside the urban compacts.

# Challenges

A number of factors have been identified that pose a risk to pavement preservation efforts and have the potential to directly or indirectly impact the actual service life extension benefit from our pavement preservation treatments.

## *HMA Erosion*

In recent years, MaineDOT has observed a significant reduction in the service life of its hot-mix asphalt (HMA) pavements. The service life reductions have primarily been caused by excessive rutting or raveling of material from the HMA mat. The raveling phenomenon has been termed as "HMA erosion" by the MaineDOT (formerly "aggregate loss"). The spread of the erosion distress has caused a significant increase in the deterioration rates of paving projects for recent MaineDOT paving projects.

The HMA erosion distress was first observed in the mid 2000s on projects built in Aroostook County. The distress is defined by the loss or raveling of aggregate and matrix (composed of asphalt and fine aggregate) from the pavement surface. After less than a year, the HMA surface has been observed to lose much of its initial surface integrity within travelled way sections. The loss is generally exaggerated in the wheel paths and measured as a rut, even though no plastic deformation is occurring. The erosion of material continues until the wear extends down to the underlying layer in the most severe cases. Figure 2 shows an example of a severe case of erosion on a MaineDOT project. This particular example is from a shim and ¾" HMA overlay project on Route 1A in Holden. Although this picture was taken eight years after initial construction, the wear through the new pavement occurred less than five years after paving was completed.

***Figure 2 - Example of severe HMA erosion through surface into underlying layer***

In 2010, MaineDOT launched an investigation into the cause and potential remedies for the erosion distress in its HMA pavements. Numerous research efforts have looked at the factors contributing to pavement distress and the ways in which MaineDOT can extend the service life of pavement. This effort continues in order to significantly extend the service life of HMA pavements in Maine. Engineers at MaineDOT are engaged in local and national research related to the durability of HMA and the development of innovative solutions. Maine is not the only state dealing with these types of challenges as there is significant national focus on the durability of HMA pavements. The efforts at MaineDOT have shown progress, as we have seen a reduction in the severity of this distress in recent projects.

## *Non-Paving Costs To Paving Projects*

Historically, a significant portion of pavement preservation project costs have not been pavement-related. Work such as restoring ditches, guard rail repair/updates, ADA compliance upgrades to pedestrian facilities, retaining walls, and drainage structure replacements all have been included as part of our pavement preservation projects. Because these are usually somewhat small quantities, the work has become quite a significant percentage of the overall project cost. We have leveraged MaineDOT's Maintenance and Operations forces to do some of this work in advance of paving to an extent which has stretched our pavement preservation dollars, but more can be done to achieve economies of scale savings for these activities.

# MaineDOT's Plan to Cost-Effectively Manage Our Highways

**MaineDOT has been striving to meet the performance objectives set forth in Title 23 for the condition of our highway pavements. We are now half way through the performance period and it is clear that available funding has not been adequate to meet those goals. In keeping with the Department's strategic plan objectives, responsible risk-based asset management principles, and practices required by MAP-21, the Roads Report team recommends the following prioritization to resource allocation.**

1. **Fully fund the preservation needs of our built highway network.**
2. **Continue historic funding of Light Capital Paving (LCP).**
3. **Continue historic funding of safety and spot improvement and mobility projects.**
4. **Fully fund the drainage structure maintenance needs of aging infrastructure.**
5. **Continue historic funding of PMRAP.**
6. **Strategic investment in highway reconstruction/rehabilitation.**



## 1. Fully fund the preservation needs of our built highway network

The cornerstone of the Department's asset management plan is the preservation of investments made in the built highway network. The cost to preserve the network using current pavement preservation treatments and highway corridor priorities would be $122 million per year.

- By adopting the new highway corridor priority system and implementing the Cyclical Pavement Resurfacing (CPR) program proposed in this document, the Department can meet preservation needs at the lower cost of $107 million per year, paving approximately 430 centerline miles each year.

**This strategy would add enough service life extension to the built highway system each year to meet or exceed the annual service life loss for that system.**

## 2. Continue historic funding of Light Capital Paving (LCP)

This cost-effective treatment is the only tool currently available to maintain safety and serviceability of our unbuilt and lowest priority roadways and is generally applied to approximately 600 centerline miles each year. Historical funding of $33 million per year is sufficient to continue this successful program. This figure includes the approximately $10,000 per mile, or $6M per year expended by the department's Bureau of Maintenance and Operations in support of and advance of LCP work each year.

## 3. Continue historic funding of safety and spot improvement projects

Safety and spot improvements have historically been funded at approximately $20 million per year. Some of these projects add service life to our built highway system, but that is not the main purpose and need for the program.

## 4. Fully fund the drainage structure maintenance needs of our highway network

One of the greatest risks to our highway assets is the potential failure of drainage conduits that make up our aging drainage infrastructure. This is particularly critical with our large culvert inventory, where a

failure can close a road or even result in a crash. Historically, many of the smaller cross culverts and closed drainage structures and conduits were replaced as part of highway reconstruction/rehabilitation/mobility projects or replaced with Maintenance Funding upon discovery of a failure of these structures. The department's shift towards pavement preservation will require more vigilance in determining those structures/systems most at risk of failure. This can be accomplished by increasing the frequency of inspection combined with a proactive, systematic approach to replacing those large culverts in poor or critical condition.

- A funding level of **$12 million per year** is needed to maintain/replace large culverts. Recent work plans have included $8.8 million per year to work towards this need, but the risk of failure associated with these structures warrants a separate program to ensure timely and appropriate replacement/repair.
- An additional **$5.5 million per year** would address the smaller cross culvert maintenance/replacement need for those not already included as part of reconstruction/rehabilitation/mobility projects.
- Closed drainage system improvements/replacements need funding of approximately **$4.5 million per year** for just those structures located on highway assets outside of urban compact areas. The need for these systems within urban compacts has not yet been quantified.

## 5. Continue historic funding of PMRAP

The department has generally funded the PMRAP program at $8 million per year. This cost-effective treatment is used to correct structural and/or geometric deficiencies on approximately 30 miles per year of our lower priority highways (unbuilt HCP 3 and HCP 4) to reduce annual maintenance costs and increase safety for the travelling public. Once applied to a highway section, a determination is made as to whether that section is improved sufficiently to be considered built and therefore eligible for pavement preservation funding (for HCP 3 CPR treatments), or will continue to be addressed by Light Capital Paving (which would be used for insufficient HCP 3s and all of the lowest priority roads).

**The Roads Report team recommends fully funding the first five priorities ($191 million) in this section before allocating funds to highway reconstruction/rehabilitation.**

## 6. Strategic investment in highway reconstruction/rehabilitation

Investment in highway reconstruction/rehabilitation generally returns a highway to new condition by repairing structural, geometric, and drainage issues. The resulting pavements are then in a condition where they can be preserved using cost-effective pavement preservation treatments for an extended period of time. Possible sources of funding include TIGER and FASTLANE grants, and municipal-state partnerships.

**Status quo funding level: $56 million per year**

This is the average annual expenditure for these activities from 2011 to 2015 and addresses approximately 34 miles-per-year on average.

# Appendix A – Roads Report Team Members

**Joyce Taylor, P.E.,** Chief Engineer
**James Havu, Assistant Engineer,** Highway Management, Results and Information Office
**Robert Skehan, P.E.,** Highway Management Engineer, Results and Information Office
**Anne Carter, P.E.,** Assistant Highway Management Engineer, Results and Information Office
**Shawn Davis, P.E.,** Transportation Resource Manager, Bureau of Maintenance and Operations
**Brad Foley, P.E.,** Program Manager, Highway Program, Bureau of Project Development
**Andrew Bickmore, P.E.,** Director, Results and Information Office
**Scott Bickford, P.E.,** Assistant Highway Program Manager, Bureau of Project Development
**Dale Peabody, P.E.,** Director, Transportation Research, Bureau of Planning
**Kyle Hall, P.E.,** Southern Region Engineer, Bureau of Maintenance and Operations
**Richard Crawford, P.E.,** Assistant Director, Bureau of Project Development
**Derek Nener-Plante, P.E.,** Asphalt Pavement Engineer, Bureau of Project Development

# Appendix B – Glossary of Terms

**23 M.R.S. § 73, sub-§7** - Referred to as Title 23 in this report, sub-§7 states legislated goals for safety, condition, and service for Maine's highway network and bridges.

**AADT** - Annual Average Daily Traffic - The total yearly traffic volume on a given highway segment divided by the number of days in a year. AADT is expressed in vehicles per day (vpd).

**ADA** - Americans with Disabilities Act - The Americans with Disabilities Act prohibits discrimination and ensures equal opportunity in employment, federal, state, and local government services, public accommodations, commercial facilities, and transportation for persons with disabilities.

**ARAN** - Automatic Road Analyzer - Data collection vehicle used to collect roadway condition data while traveling at highway speeds.

**CHIP** - Collector Highway Improvement Project - Generally, the reclamation or the addition of material with a new full depth pavement with some areas within the project limits being treated with an overlay, or with full reconstruction. CHIP projects are employed on major collector highways.

**CIPR** - Cold In-Place Recycling - Removing and processing an existing pavement surface, and then placing the resulting material back on the roadway, all within a single construction operation.

**CSL** - Customer Service Levels - A measure of how a road compares to other roads of the same priority across the state based on safety, condition, and service.

**CPR** - Cyclical Pavement Resurfacing - A new light designed mix to be used on the new HCP 3.

**dTIMS CT** - Customizable asset management software used by many States and world-wide. MaineDOT has configured dTIMS for highways and bridges to manage asset condition data, track deterioration, predict future conditions and evaluate the benefits of different funding scenarios.

**FHWA** - Federal Highway Administration - A branch of the US Department of Transportation that administers the Federal-Aid Highway Program, providing financial assistance to states to construct and improve highways, urban and rural roads, and bridges. The FHWA also administers the Federal Lands Highway Program, including survey, design, and construction of forest highway system roads, parkways and park roads, Indian reservation roads, defense access roads, and other federal lands roads.

**FWD** - Falling Weight Deflectometer - A testing device used to evaluate the physical properties of pavement and to determine the strength of the pavement base.

**HCP** - Highway Corridor Priority - A classification system based upon factors of importance including the economic importance of the road. All 23,400 miles of Maine public highways are divided into six priority levels.

**HIPR** - Hot-in-Place Recycle - An on-site, in-place method that rehabilitates deteriorated asphalt pavements and thereby minimizes the use of new materials.

**HMA** - Hot Mix Asphalt - A combination of stone, sand, or gravel bound together by asphalt cement.

**IRI** - International Roughness Index- A measure of highway smoothness. The lower the number, the better.

**LCP** - Light Capital Paving - Light Capital Paving, also known as maintenance surface treatment, is typically the application of a 5/8" nominal overlay, used as a holding action on unbuilt roads.

**LM** - Lane Miles.

**LMY** - Lane Mile Years.

**MaineDOT** - Maine Department of Transportation.

**MPO** - Metropolitan Planning Organization - A federally mandated and federally funded transportation policy-making organization this is made up of representatives from local government and governmental transportation authorities. Maine has four: Androscoggin Transportation Resource Center (ATRC), Bangor Area Comprehensive Transportation System (BACTS), Kittery Area Comprehensive Transportation Study (KACTS), and the Portland Area Comprehensive Transportation System (PACTS).

**MTA** - Maine Turnpike Authority - A quasi-state agency established chiefly with the purpose of constructing, maintaining, reconstructing, and operating a toll turnpike from Kittery to Augusta.

**NBI** - National Bridge Inventory - A database compiled by the Federal Highway Administration, with information on all bridges and tunnels in the United States that have roads passing above or below.

**PCR** - Pavement Condition Rating - An evaluation compiled from the severity and extent of pavement distresses such as cracking, rutting, and patching. Uses a scale of 5 (perfect) to 0 (fully deteriorated).

**PMRAP** - Plant Mixed Recycled Asphalt Pavement - A pavement mix consisting of reclaimed asphalt materials used as a base to add structure and correct deficient cross-slopes.

**PPP** - Pavement Preservation Program - Paving done to a highway facility that facilitates the preservation of the investment.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